

Winery Energy Management Project: Cape Mentelle Audit

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Introduction

This energy audit is funded by the Grape Wine Research Development Corporations (GWRDC) Regional's program. The Regional's WA program is managed by the Wine Industry Association of WA (WIAWA) and includes the winery energy management project which aims to help producers reduce the energy component of their production costs.

Cape Mentelle Vineyards (CMV) are one of three wineries that are receiving level 2 energy audits. These audits are aimed at developing the knowledge and understanding of how much and where energy is used in a typical winery. The aim of this is to develop case studies that can be used by other wine producers of different sizes and assist them in reduce their energy use.

Cape Mentelle Vineyards (CMV) are based in Margaret River and process approximately 1300 tonnes of fruit to produce over 120,000 cases a premium wine each year for domestic and export markets.

Since 1970 when they released their first wines CMV have been widely recognised as a producer of premium wines and as an industry leader. This position has been reinforced recently when CMV become the first producer in WA to gain both the EntWine winery environmental certification and EntWine viticulture environmental certification codes. Energy management is one of the platforms within the EntWine winery code and for certification the producer is also required to complete the wine industry greenhouse gas calculator (or NGRS).

The CMV site where this audit was conducted is where all the winemaking processes from harvesting to bottling are carried out as well as where the vineyards are managed from, finished wine is warehoused and the cellar door is located.

1.0 Site Description

The Cape Mentelle Vineyards are located at sites throughout the Margaret river region. The winery and cellar door are located at 331 Wallcliffe Rd Margaret River. The picture below shows the different areas at this site.



2.0 Methodology

As part of the winery energy management project this audit process will follow the normal processes as set out in dot points below. From this a case study will be developed and made available to the wine industry.

- A desk top analysis of energy use data provided by CMV
- Site visit to compile an appliance / equipment list
- Staff interviews
- Data analysis
- Research
- Recommendations

2.1 Review of Billing Information

Prior to the site visit a review of the previous 12 months of energy billing data was analysed to determine energy usage patterns. This data included Vintage 2009 which was considered as a fairly normal vintage, though it should be noted that there is always variation between vintages in regard to tonnes of fruit processed and temperature patterns which will also impact on energy use.

2.2 Data Collection / Equipment Audit

A list of energy consuming equipment and appliances and their nominal power rating was compiled during an on-site audit. Winemaking and maintenance staff were also interviewed to ascertain the pattern and frequency of use for this equipment. This information was used to estimate the proportion of energy used by this equipment and for each of the production processes and work areas. This list is separate to this audit report and will be supplied to CMV in XL format for future use.

2.3 Staff Interviews

Staff interviews (on-site, phone & email) have been conducted to develop a good understanding of CMV specific wine making practices and the production processes involved in these.

2.4 Data Analysis

The use of the Synergy data combined with the equipment audit and staff interviews provided a good understanding of how much energy is consumed in each of the production areas / processes. Graphs were created to yield the following information:

- Electricity and LPG use
- Greenhouse gas emissions
- Peak / Off peak energy use and cost analysis
- Energy use by CMV site locations

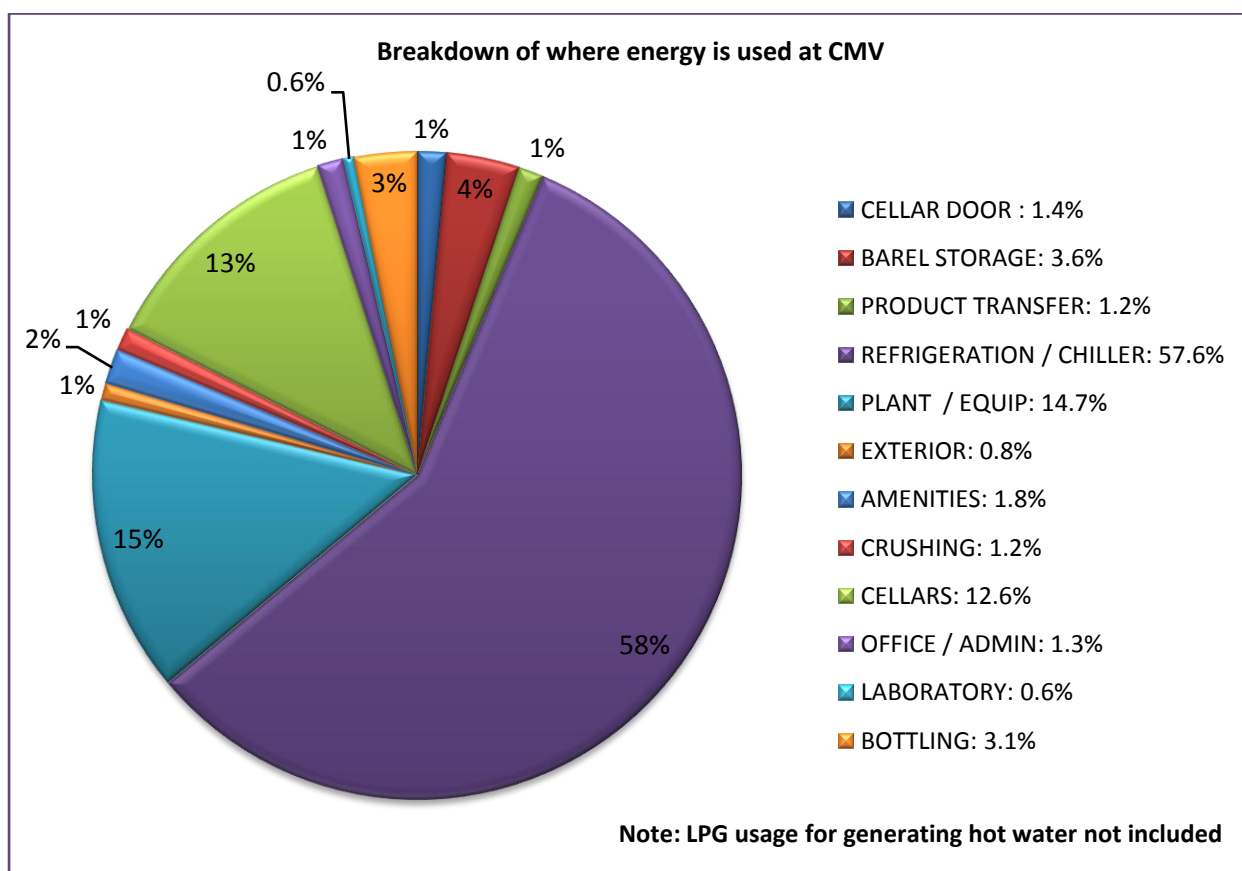
3.0 Results and discussion

Although energy efficiency opportunities may be made across the board, more effort should be directed to where the most energy is used. Identified opportunities have been developed through analysis of the audit data and the production processes. As energy is also linked to water and waste management these should also be incorporated in the same continuous improvement program.

3.1 Energy use by location

A total of 650,000 kWh were used throughout the 12 month energy audit / review period. Chart 1 provides details on where energy is used throughout the CMV site based on the audit of equipment at CMV and staff interviews.

Chart 1



3.1.1 Refrigeration: 58%

CMV has a typical air cooled brine refrigeration system designed to chill the brine (water and 24% ethanol) down to minus 7°C. The chilled brine is circulated throughout the winery through a network of brine lines. The heat transfer process occurs when the brine is allowed to pass through a tanks brine jacket or when both the product and the brine pass through a separate heat exchanger. After this the now warmed brine returns to the brine tank for more refrigeration. Some of this refrigeration energy is also used to provide air space cooling in the barrel shed.

3.1.2 Plant Room: 15%

The following plant equipment items have been combined to represent plant room energy use:

- **Air compressors: 56%** of plant room machinery.
The predominant use of compressed air at CMV is to provide air to the three rotary presses during vintage, with the supply requirement being high volume low pressure. At peak times there are two 37kW compressors in operation to meet demand.
- **Nitrogen compressor: 36%** of plant room machinery.
Nitrogen gas is injected under low pressure into the tanks head space to protect the wine from exposure to atmospheric oxygen. Nitrogen is also used for a similar purpose during the bottling process.
- **CO₂ bulk storage: 4%** of plant room machinery.
The compressor on this bulk storage cylinder is used to keep the CO₂ chilled under pressure as liquid. CO₂ is then decanted from the bulk storage cylinder in the dry ice format. Dry ice is used in the tanks head space when transferring wine to prevent exposure to atmospheric oxygen as it's heavier than air. It's worth noting that 1 kg of dry ice converts to 540 litres of gas.
- **External cool room / sea container: 4%** of plant room machinery.
This has been used to store vine cuttings and for short term fruit storage during vintage.

3.1.3 Cellars: 12.6%

Cellars (stainless cellar, red cellar and cellars 3 to 5) energy use includes:

- Heating Ventilation Air Conditioning (HVAC) - 60%.
- Lighting -30%
- Equipment (other than pumps) - 9%

3.1.4 Barrel storage: 3.6%

Barrel storage air space cooling comes from a fan coil unit using chilled brine from the main refrigeration system. Energy use for this has been included in the refrigeration calculations. In this barrel shed there is a separate barrel ferment section that also uses a fan coil unit combined with hot water for air space warming. The two main energy items in the barrel shed are:

- Lighting - 60%
- Electric forklift charger - 30%

3.1.5 Product transfer: 1.2%

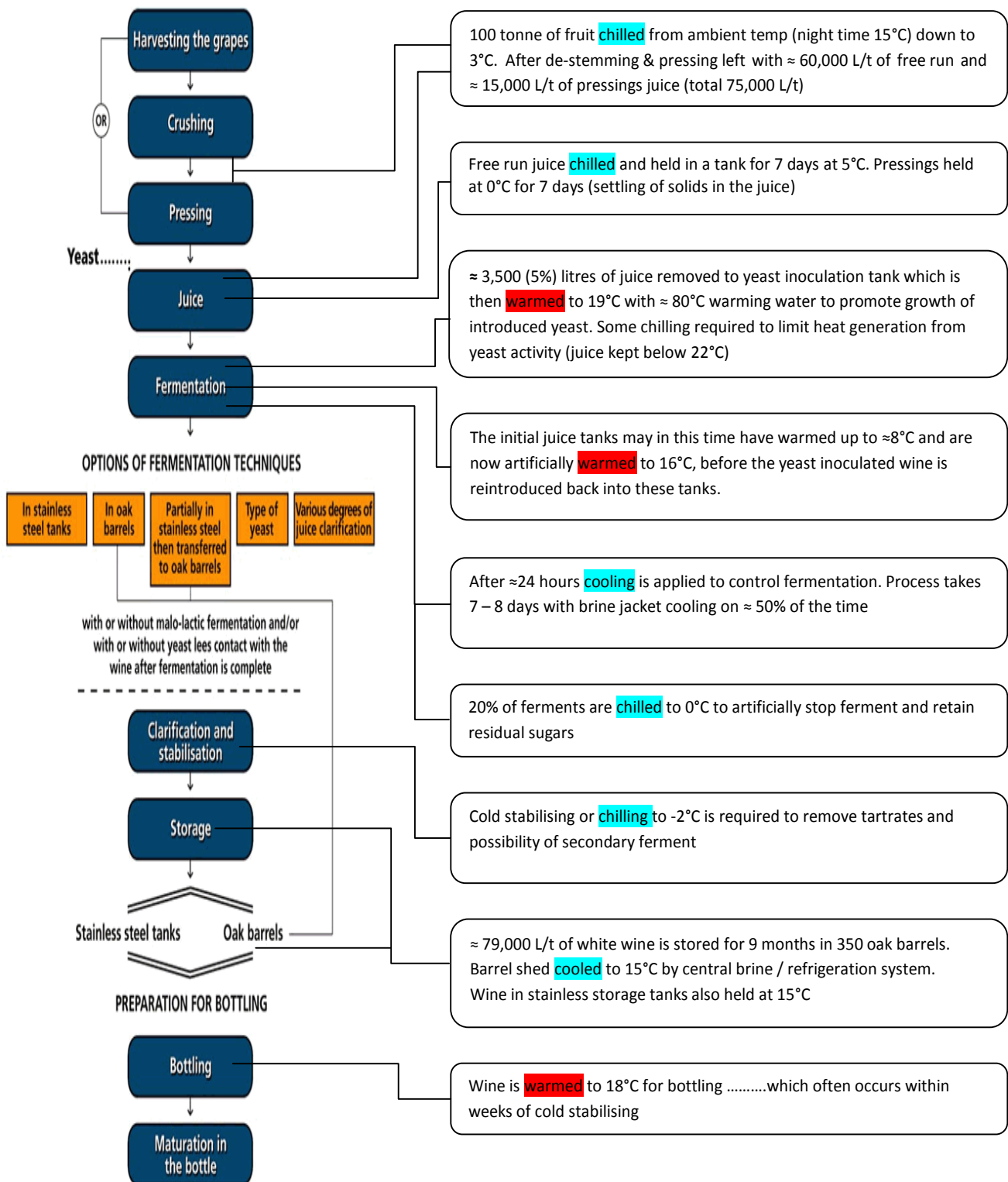
Energy use from transfer pumps totals approximately 7800kWh per annum. This has been based on 13 ML juice / wine transferred; Average pump size of 4kW; Average transfer rate of 7kL /h + cleaning time.

3.2 Energy use by processes

3.2.1 Fermentation process

The largest portion of CMV energy use occurs as a result of the winemaking processes during the vintage period. In particular, it is the fermentation process where juice is converted into wine that uses the refrigeration energy in the cooling phases and hot water in the warming phases of this process. The flow chart over-page follows the heating / cooling processes involved in converting 100 tonnes of fruit into finished wine.

Linking white wine fruit processing with temperature management at CMV in Margaret River



Cape Mentelle process 600 tonne (450,000 L/t) of whites each vintage (February – May)

3.2.3 Hot Water: 26.5 tonnes LPG

Calculations are based on 26.5 tonnes of LPG purchased with 90% of this used for generating hot water.

23.8 tonnes of LPG (90%) is equal to 47,000 litres of gas (1 tonne: 1975 ltr). 47,000 litres of gas converts to 313,000 kWh of energy. This has not been included with the appliance / equipment list as different greenhouse gas accounting formula apply for LPG.

Hot water is required for cleaning barrels, tanks and for the warming of juice in the fermentation process.

3.2.3 Seasonal variations to energy use

Table 1

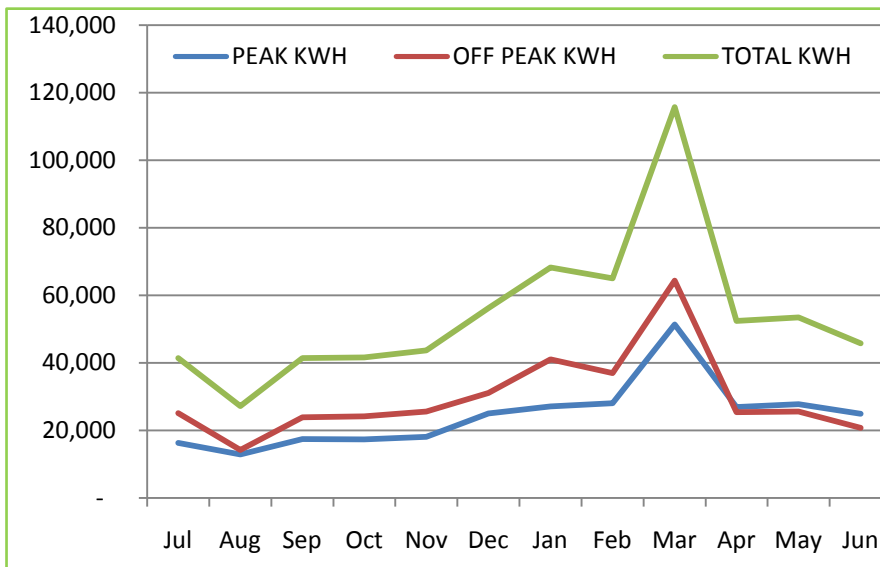
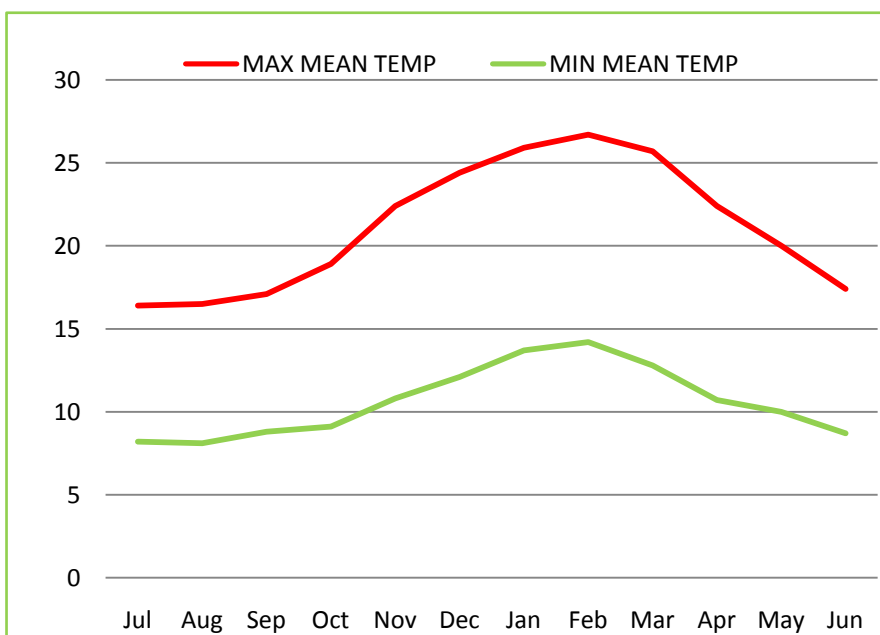


Table 1 highlights the increases in both peak and off peak energy use for the vintage months, when vintage energy use peaks at 116,000 kWh in March. The hottest months as seen in table 2 start in December and coincide with the commencement of irrigation scheduling in the vineyards and finish just prior to the end of vintage.

Table 2

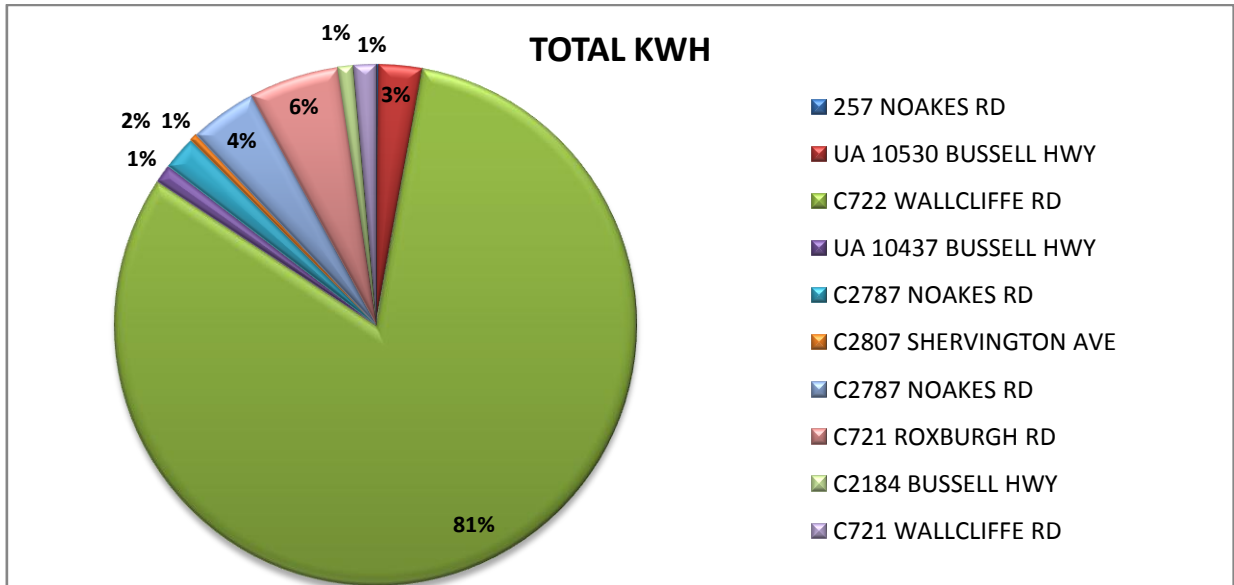


Air conditioner energy usage in this time frame is mainly in the cellars. The mean min / max temperature chart for this region (table 2) highlights the fact that air conditioning for cooling is not required for most of the year. Temperature controlled ventilation fans would be appropriate to take advantage of night time cooling potential.

3.2.4 Vineyard water / energy use

CMV have 200 ha of vineyards and irrigate at a rate of 0.6 – 0.9 ML per ha, with some double handling of water (bore to storage then storage to vineyard). Energy use for vineyard irrigation has not been included in the scope of this audit but it is worth noting that it has a noticeable impact on total energy use. Chart 1 is a representation of Synergy billing data and highlights the fact that 19% of CMVs total energy use is at these vineyard locations. Energy use for lawns irrigation at the CMV audit site is included in the C722 (81%) figure and will contribute to the pre vintage (December – January) spike in energy use at CMV.

Chart 1



3.3 Energy consumption and green house gas emissions at CMV

Chart 2

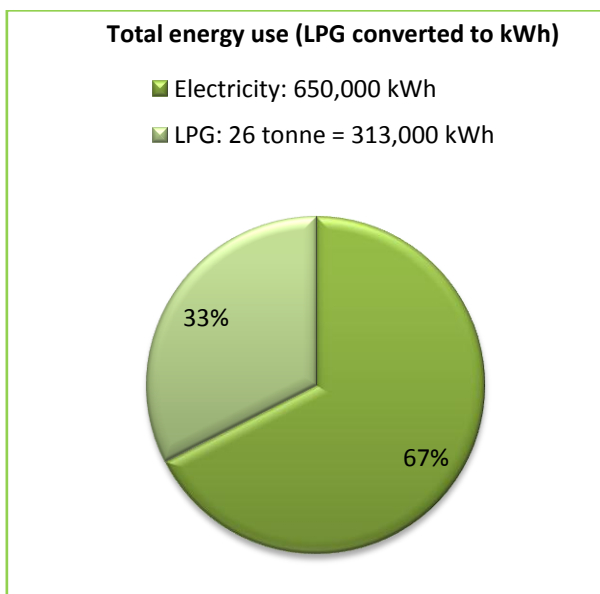
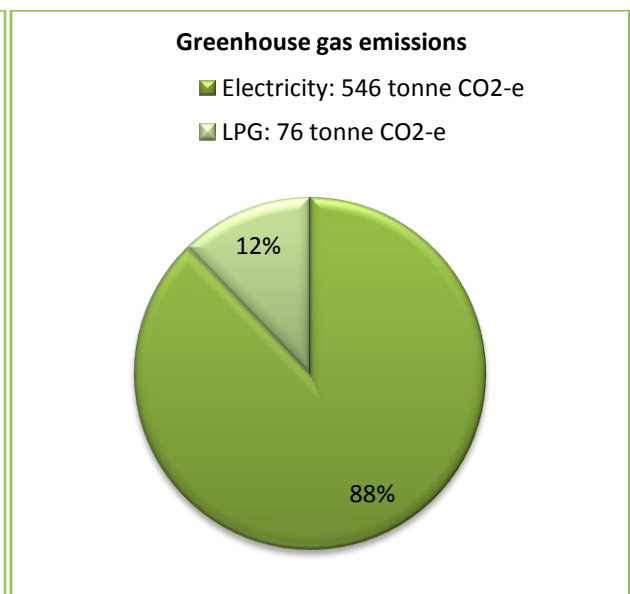


Chart 3



3.4 Peak / Off Peak energy use and Synergy tariffs

Chart 5 shows the breakdown costs associated with peak / off peak energy use for the next 12 months (based on 1/7/10 - R3 tariff and existing energy usage patens). This highlights the need to switch energy use to off peak where possible and as mentioned in 3.3.4 does not include vineyard irrigation energy use.

Chart 4

Chart 5

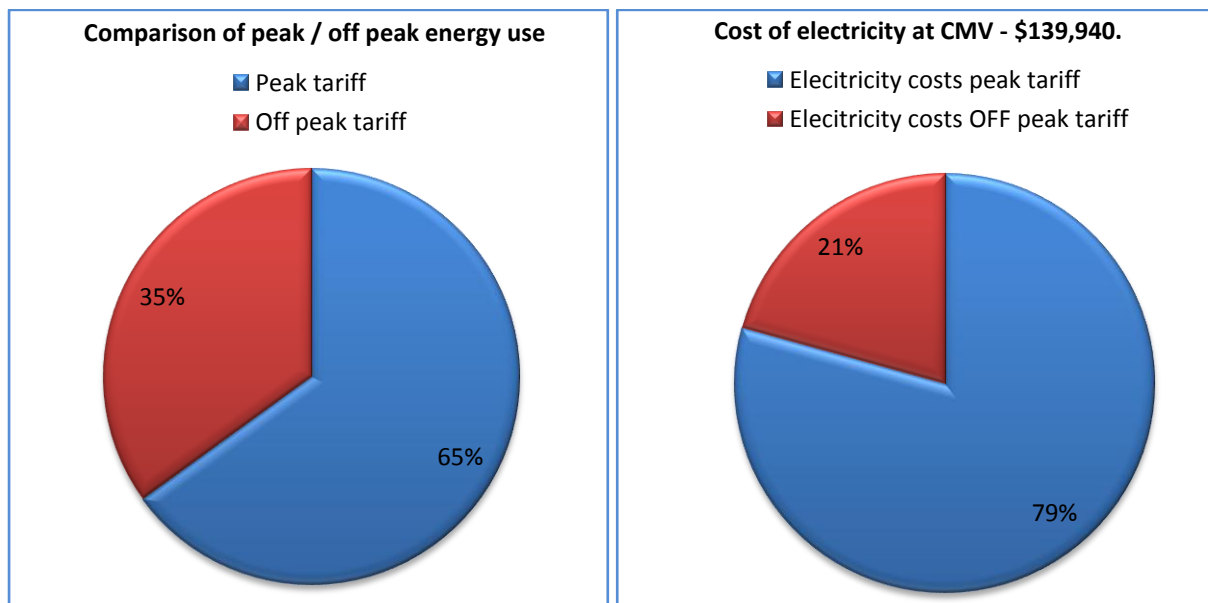


Table 3: Synergy R3 tariff and charges- Time-of-use periods: (from Synergy web site)

Period	Day	Time
Peak	Mon-Fri	8:00am-10:00pm
Off-peak	Mon-Fri	After 10:00pm and before 8:00am: All weekend

Synergy R3 tariff charges (GST inclusive)

Tariff	Charges	July 2008	Current	From 1 July 2010
R3	Supply charge - \$ per day		1.62	1.79
	Electricity charge - cents per unit for:			
	Peak rate charge	19.	28.46	31.31
	Off-peak rate charge	6.1	8.76	9.64

3.5 Benchmarking energy use

This is useful when comparing your winery with wineries of similar size, production methods, product quality, climatic conditions etc. More importantly its value is in benchmarking for continual improvement. Medium sized premium producers tend to be the most inefficient in regard to energy use as they don't have economies of scale that larger producers have and usually don't have the business owner/s on site providing more direct accountability that the smaller producers have.

The preferred wine industry benchmark for quantifying energy use is kWh per litre of wine produced.

CMV use 1.06 kWh/L (LPG & Electricity combined).

Though limited, existing benchmarks suggests that similar producers to CMV range between 0.75 and 2.0 kWh/L.

4.0 Energy saving options

Energy saving options range from low cost in house strategies to the higher cost options that require longer term financial planning, logistical planning and specialist technical advice. CMV have good staff engagement practices in place which can be fine tuned for improving energy management by:

- Discussing the drivers for reducing energy use with staff such as: EntWine; marketing; environmental; financial etc and how this impacts on all staff.
- Engaging staff and developing energy management ideas and strategies.
- Setting achievable targets.
- Implementing practice change strategies and.
- Ensuring that the process for continuous improvement is sustainable.

4.1 Practice Change

The importance of practice change cannot be underestimated as a low or no cost solution for achieving significant reductions in energy use, unfortunately it can also be one of the hardest things to achieve and maintain. The benefits of achieving real practice change are realized when staff / management are actively participating in energy reduction practices and find the solutions for continuous improvement in energy management. Practice change is more sustainable when starting with the more achievable changes such as turning of appliances when not in use, setting appropriate equipment to energy save mode or reprogramming or installing timers to reduce hours of use. Another benefit is that these practices changes are often repeated by staff within their own homes

4.2 Refrigeration

Refrigeration at CMV uses approximately 360,000 kWh a year which works out to over half of the wineries energy use. With the new tariff this will cost of over \$74,000 for the next 12 months (without further tariff increases and assuming same peak / off peak usage). Setting an initial though achievable energy reduction target of 25% for this system will save over \$18,000. This figure is an approximation only and more accurate data will come with the installation of a sub-meter.

For this audit report refrigeration has been separated into refrigeration plant and refrigeration system.

4.2.1 Refrigeration Plant

This air cooled Carrier system was installed at CMV in 1998 and requires the support of an older Luke Chiller during vintage to meet demand. Identified issues with this unit include:

- Not performing to task requirements.
- Does not have the control systems in place to achieve optimum efficiencies.
- High cost of maintenance.
- In need of major expenditure for repairs (see condenser damage in figure 2). The efficiency of the system is measured by the co-efficient of performance (COP). This is measured in kilowatts and is the ratio of cooling output compared with energy input - the higher the COP, the more efficient the system. The ability of this unit to achieve a good COP is limited unless these repairs are achieved.
- Though it has good air movement to and from the unit, it would also benefit from shading to reduce heat load on this unit
- Backup system is even older and also in need of maintenance

There is already justifiable planning in place to replace this unit. This process should involve working with the local refrigeration engineers who would be responsible for the servicing and maintenance of the new unit and where applicable incorporate recommendations from the GWRDC funded refrigeration efficiencies project. Investigating the potential for preheating water should be included in this process.

Sub-metering would be an important energy management tool for this unit or if this unit was replaced.

4.2.2 Refrigeration System

Issues with the refrigeration system include:

- **One brine tank:** It has been assumed that there is no partition in this tank to separate chilled brine from the warmed return brine. A second tank allows warmed brine to return to one tank from where it can be more **efficiently** chilled, before returning to the chilled brine tank for winery use.

Figure 1: Refrigeration plant



Figure 2: Damaged and blocked condenser



Figure 3: Brine tank



- **Lacking volume:** The brine tank holds approximately 9,500 litres plus the additional brine in the supply system. Installing the second tank also means that there is a larger volume of brine in the system that can be chilled with off-peak energy and the chiller can have more efficient run times.
- **Fixed speed brine pumps:** The brine pumps are using around 30% of the combined refrigeration plant / system energy. Installation of variable speed controllers on the brine pumps can reduce pump energy use by up to 50% while maintaining a set flow rate or pressure against a variable demand. At present outlet valves as seen in figure 4 are partially closed to adjust flow / pressure or reduce cavitation. The 7.2 kW Grundfoss pump would benefit the most from this with an expected payback period of less than 12 months.
- **Lack of insulation on stainless wine tanks:** Insulation on all parts of the brine supply / return system is essential to minimize loss of refrigeration energy to the environment. There are a number of areas throughout the tank farm and brine supply system that require insulation such as the RF tank in figure 5 and the valves as seen in figure 4. Thermal engineers can calculate the energy loss through each of the un-insulated areas.

Figure 4: Brine pumps



Figure 5: Iced up cooling jacket: No shade or insulation



4.3 Hot water supply

The Hot water generating process at CMV is the sites second highest energy user. **Issues with this system include:**

- Hard to manage both warm and hot water requirements.
- Does not always meet demand (not used for bottling machinery sterilizing).

Energy management should focus on hot water temperature requirements, what practices require hot water and how efficiently this is used. **Options for improvement include:**

- Preheat water supply by cogeneration from refrigeration system or solar. For this to be effective an insulated holding tank and circulating pump would be required. Return water from the barrel ferment room and from tank warming would go to this tank. **NOTE:** As a rule of thumb it takes 11.6 kW of energy to raise 1000 litres of water 1 degree.
- If funding was available implementing a separate warming system (40 degrees) and hot water for cleaning (70 plus degrees) system would be a more manageable option.
- Insulation quality on copper hot water lines needs to be assessed and improved where applicable to minimize heat energy loss to the environment.
- Assess run times or amount of hot water used in the cleaning processes for barrel and tank washing and reduce if appropriate.

4.4 Nitrogen generator and irrigation system

The main issue with this unit is that, though it has the capacity to do so it does not meet site demand requirements. Nitrogen is a difficult gas to use for head space protection as it's a light gas and there needs to be some venting mechanism in the head space area to allow for contraction / expansion within the tank.

Options to reduce nitrogen loss include:

- Check for leaks in the system and ensure lids are secure.
- Ensure tanks are isolated when empty or when doing additions from the top.
- Check regulator pressure though as it's a very low pressure that's required this may be hard to adjust. The tank vent needs to vent at a higher pressure than the nitrogen regulator to avoid continual flow through of nitrogen. This also raises the question of how does nitrogen force out the heavier oxygen in the head space air.
- **Argon gas.** Argon is a heavy inert gas that can be dosed into the head space and has proven to be more cost effective while providing better protection to the wine. Cost of leasing nitrogen generator to be factored in.

Figure 6



4.5 Lighting

The energy use for **lighting** when calculated separately **accounts for 9% of the sites energy use**. There are now effective, viable lighting options available that will enable CMV to reduce lighting costs by up to 40%. Before replacing existing lights, it is worth determining lighting requirements for each work area while keeping in mind the AS1680 lux level requirements in the workplace. Table 1 was developed as a result of lux meter readings during the on - site audit.

Area	Lux	Comment - 11.00am - 2.00pm (overcast)
Cellar Door Sales	60 - 150	Low lighting level for retail. CMV have trialled LEDs. New style LEDs offer a better colour spectrum to make suitable for the cellar door and barrel display areas while providing substantial reductions in energy use
Stainless Cellars	360- 450	Higher directly under lamps. The 450 W (including ballast) metal halides can be replaced by 150 W induction lamps or 150 W compact fluorescents. Both of these lamp options have an E 40 fitting and can be installed into the existing fixtures.
Barrel Storage	160 - 250	Low lighting level. Could be improved by lowering lights, utilising tri-phosphors or T5s, better diffusers and reflectors. A 50% reduction in lighting energy use can be achieved in this building
Lab	400 - 700	OK
Offices	160 - 700	Higher directly under lamps. 1 row of office lights off. Suitable for de-lamping where excessive and can be progressively replaced with more efficient lamps as lamps need replacing
Offices	700	Individual offices suitable for de-lamping and or replacing with more efficient options
Meeting Room	160	Natural light only. Lights off during walk through

4.6 Compressed air supply

The two 37kW air compressors meet supply demand. One unit should be enough to meet supply demand though this would involve installing a large air receiver in or near the press area. The rapid on / off cycling of the compressors that was apparent during site visit will be minimised with the installation of a second air receiver. This action will reduce start up energy use, improve run time efficiencies and improve the compressors life cycle. Other energy saving measures include:

- Reduce set point pressure (was at 710kpa during site visit) as a rule of thumb.....a **14 kPa reduction** in pressure results in a **1% reduction** in **energy** use. As presses require high volume low pressure the installation of a large air receiver near the presses means that the pressure set point can be reduced with energy saving of up to 20%.
- Turning off on weekends or when not required. May be viable to replace one 37kW unit with a small non – vintage compressor.
- Check for leaks at a time when the workplace is quite.
- Take note of supply system pressure at the end of the day and first thing in the morning on a regular basis to determine compressed air loss rates. Air leaks often account for 20 - 30% of compressed air energy use.

5.0 Conclusion

This report has identified a number of energy saving opportunities at CMV and provides the foundations for ongoing energy management at this site.

In all areas, energy efficiency improvements can be achieved at no or low cost. Behavior changes such as better work scheduling and turning off equipment that is not in use can be embedded in staff training and induction. These can be put into action as soon as possible for early results.

Lower cost actions such as equipment or system repairs can be implemented as part of the general maintenance program. It is a case of scheduling and prioritizing these actions to ensure cost effective outcomes.

Longer- term actions require careful planning which needs to keep potential energy savings in context with financial outlay and the life cycle costs of alternative options. When replacing plant or equipment it is important to minimise the demand on the system first. For example if replacing the refrigeration plant it would be logical to minimise demand or energy loss by improving the refrigeration system first. This can also lead to financial savings on plant / equipment purchase costs as a smaller replacement may then be more appropriate.

Sub-metering of major energy using items, benchmarking energy use and setting achievable energy reduction targets are important aspects to a sustainable, continuous improvement program.

